IT INCONSISTENCIES & ELECTRONIC BUSINESS IN MEDICAL PRACTICES: MODERATED BY PRACTICE SIZE

Jenny Gibb, Jarrod Haar
University of Waikato

Abstract
The e-business literature suggests organizations can significantly benefit from the adoption of information technologies. However, such benefits within the health sector are severely hampered by numerous complexities and inconsistencies. This study of 108 New Zealand General Practices found IT inconsistencies were negatively related to e-business activity (receiving) but held no effect on e-business activity (sending). Further, we tested for the moderating effects of practice size (based on number of patients), and found this to have a significant effect. Large practices were able to buffer the negative influence of IT inconsistencies on e-business activity (receiving), while smaller practices were severely hampered by IT inconsistencies. The implications for e-businesses within the health sector are discussed.

Key words: *IT health, IT problems, practice size*

INTRODUCTION

It is critical that information technology (IT) is effectively used in order to enhance "the provision of high-quality care in the increasingly complex health care field (Dowd, Gans, Hammons, & Kralewski, 2005, p.5). Evidence shows the availability of specific IT applications to be associated with improved quality of care (Bates & Gawande, 2003; Johnston, Par, & Walker, 2004), increased patient safety (Gaba, 2000), and direct benefits to the financial situation of healthcare providers (Chen, Hough, & Lin, 2005). Despite these benefits, the adoption of IT in the health sector lags behind other industries by as much as 10 to 15 years (Goldschmidt, 2005) due to a series of issues surrounding the complex needs of health care providers and the associated costs.

Information is undoubtedly a valuable intangible asset (Sampler, 1998) in the health sector that is regularly exchanged across a wide range of health care providers including primary medical practitioners, specialist physicians, laboratories, radiology clinics, pharmacies and hospitals (Chen, Hough, & Lin, 2005). Despite the importance and regularity of information exchange between these providers, they currently operate numerous, often disparate IT and non-IT systems that range from shared electronic patient management systems to facsimiles, telephone, electronic and postal mail (Ginneken, 2002). Within this group, primary medical practitioners, who are typically responsible for the long term care of patients (Brailer, 2005), occupy a pivotal position sending and receiving data. Given the key role these providers play and the presence of numerous health IT related problems, this paper investigates the specific nature of IT exchange problems experienced by primary medical practices and whether some practitioners are more likely to over come these problems when compared with others.

PAPER OBJECTIVES

The objectives of this paper centre on the need to develop a better understanding of the IT related inconsistencies and problems experienced by primary medical practices and how they relate to the ability of these practices to send and receive data electronically. However, the relationship between IT inconsistencies and the ability of these practices to send and receive data electronically should not be examined in isolation, as strong IT inconsistencies alone may not necessarily predict a reduced ability to send and receive electronic data.

This paper examines how the sizes of medical practices combine with IT inconsistencies in the health care sector to influence the ability of these practices to send and receive data electronically. The IT health literature has identified numerous problems relating to the adoption of computer related technologies (Brailer, 2005; Grimson & Hasselbring, 2000). Burstin, Cain, Chockely, Lee, and Young (2005) have addressed some IT adoption issues in private practice, however, to our knowledge there has been little no empirical investigation into the direct relationship between IT problems and inconsistencies in the health sector and how they impact on the ability of primary medical practitioners to send and receive data electronically. Nor, does it appear that there has been any prior research into the impact of practice size on their ability to overcome IT inconsistencies in their sending and receipt of electronic data.

IT INCONSISTENCIES

One stream of IT health literature has focused on identifying a general set of problems associated with the adoption of IT across the health sector, including the policy, operational, and security issues involved in balancing improved patient care with costs (Ginneden, 2002: Grimson, Grimson, & Hasselbring 2000; Pringle, 2003). Another group of researchers have investigated the problems associated with particular IT systems (Dowd, Gans, Hammons, Kralewski, 2005; Johnston, Par & Walker, 2004) or user groups (Burstin, Cain, Chockley, Lee & Young, 2005; Wainwright & Waring, 2000).

Drawing from the IT health literature we conceptualize primary medical practitioner IT inconsistencies to be those key problems associated with sending and receiving patient related data. Included in this conceptualization is the assumption that all primary practices possess and use basic computer related technologies and have installed an electronic patient management system. We focus on the development of four IT inconsistencies that include IT uptake inconsistencies, computer programme incompatibility, data standardization inconsistencies and speed of IT implementation by government health providers. The following section provides a more detailed discussion of each IT inconsistency.

IT Uptake Inconsistencies

At the heart of the adoption of IT in health care is the Electronic Health Care Record (EHCR) where patient medical data is recorded. Data is fed into this system is maintained and then made available to those health providers who require it. This system does, however "presents obvious integration challenges" (Grimson & Hasselbring, 2000, p.50). The building of an integrated IT health system needs to take into account the highly heterogeneous and distributed nature of IT currently used in the health sector where each provider operates by different clinical guidelines, protocols and incurs different associated costs.

There have been various IT adoption pathways followed, not only by each health provider group, but also often within each group. While over 90% of primary medical practices now have computer based billing and electronic health records, many other tasks are still completed manually by some practices, such as writing prescriptions (Grimson, Grimson, & Hasselbring, 2000). Also, paper files are typically kept for example, for the receipt of patient communication from specialist referrals. As a consequence, there is often considerable

variation in the use of manual and computerized mechanisms (Dowd, Gans, Hammons, & Kralewski, 2005). A further challenge arises from the perceived negative network effect for early health IT adopters. Commonly referred to as the *Metcalfe Effect* the value of connecting to an electronic infrastructure is seen to be proportional to the number of other connected and functioning users at the time (Metcalfe, 1995). This effect has somewhat been reduced for primary medical practices as many geographically close practices now use the same IT patient management systems. Furthermore, the strategic drive by many practices to adopt a team, rather than an individual approach to patient care has led to practices becoming even more aware of the value of exchanging data electronically (Grimson, Grimson, & Hasselbring, 2000).

Computer Programme Incompatibility

It is increasingly recognized that the more compatible computer programmes there are in the health care sector (Ministry of Health, 2005), the greater the interoperability and access to data. Further, there becomes less likelihood of healthcare provider error, by making decisions based on incomplete information (Pendery, 1998). As health care becomes more specialized and more data becomes available, the issues involved in the compatibility of computer programmes become even more complex. When there is programme compatibility, primary medical practitioners, for example, can advise a hospital if a patient has had a prior test, which reduces both the potential stress and time spent by a patient as well as laboratory cost savings if the test were to be rerun (Brailer, 2005). Conversely, if medical practices were to electronically receive hospital outpatient data this would enhance their development of post-hospital patient care programmes.

Despite recent research showing that improved IT compatibility in the United States health sector could create savings of as much as US$77 billion per annum, currently there is still much IT incompatibility between health providers (Brailer, 2005). Problems are exacerbated by the often very different IT needs of providers. For example, primary care practices require systems to manage several hundred patients, compared to large hospitals that serve several thousand patients, whereas specialist physicians are likely to have considerably less patients at any one time. Also, the computer space required to send data varies considerably, where sending X-ray electronically can take up much space, compared with that required to send a pharmacy script (Grimson, Grimson, & Hasselbring, 2000). Primary medical practitioners are therefore, still required to exchange data across a range of mediums from electronic programmes, to facsimile, or postal mail, due to the data systems of their receiving providers. This situation can result in delays in receiving data where a patient's condition has changed and decisions are based on historical data (Pringle, 2003).

Data Standardization Inconsistencies

A key driver to standardize health sector data comes from the pressure to ensure patient care is delivered based on best-practice evidence based medicine, whereby best-practice is progressively being encoded in protocols, clinical guidelines and especially in the electronic transfer of data (Grimson & Hasselbring, 2000). Although a core set of data standards is often recognized and already integrated across many health providers systems, these standards are not regularly implemented between providers who wish to exchange data. Data exchange, especially in electronic format, also requires the bundling of several sets of standards. For example, when a medical practice electronically sends a script to a pharmacy this requires the packaging of demographic, clinical and patient data (Diamond, Halamka, Overhage, Ricciardi, Rishel, & Shirky, 2005).

A number of medical practices already have shared protocols and electronic links with laboratory and radiology services, allowing the receipt of results directly to their computer

system. However, the problems in securing standardized links between primary and secondary care organizations have been described as formidable (Wainwright & Waring, 2000), where for example, in England some hospitals still use International Classification of Diseases (ICD) codes, while primary practices use Read Clinical Terms (Pringle, 2003). When developing health data standards, Ginneken (2002) drew attention to the value of building protocols for the routine exchange of predictable data that include fixed forms, predefined items and layout, such as those used in child health centers or laboratories. However, flexibility should be practiced in some situations, for example data drawn from broad specialties such as internal medicine or pediatrics should have less rigid protocols applied. Overall, Grimson, Grimson, and Hasselbring, (2000) argued that a lack of standards and/or the slow adoption of standards still stand in the way of gaining efficiencies in the electronic transfer of data between primary practices and other providers.

Speed of IT implementation By Government Health Providers

The pace at which government based health providers such as publicly funded hospital boards contribute towards the development of integrated electronic health management systems commonly appears to be frustratingly slow. This compares with the more rapid adoption of electronic patient management systems by numerous private medical practitioners (Goldschmidt, 2005). Reasons for this apparent lack of speed of adoption by government based health organizations are numerous. For example, they are required to either adhere to or integrate, a complex range of government polices, objectives, and operational issues, whereby agreements are reached over the nature, content and security of these systems, all of which have associated costs and financial constraints (Wainwright & Waring, 2000). Hence while the demand from an expectant and well-informed public for an improved health care service grows, which includes the improved integration of health IT, "the ability of the state and health care organizations to meet this demand is widening all the time" (Grimson, Grimson, & Hasselbring, 2000, p.51).

Our outcomes for the present study reflect a common approach to e-business activity, that firms sending and receiving data are both distinct and different aspects. We suggest that the four aspects noted above will combine to create an overall measure of IT inconsistencies, which will be negatively related to e-business activity. This leads to our first set of Hypotheses.

Hypothesis 1: Higher IT inconsistencies will be associated with lower e-business activity (sending).

Hypothesis 2: Higher IT inconsistencies will be associated with lower e-business activity (receiving).

THE ROLE OF PRACTICE SIZE

It has been suggested that the benefits of an IT system may be more effective for larger firms (Kim & Mahoney, 2006). Typically, larger firms investment more in IT assets (Brynjolfsson, Malone, Gurbaxani, & Kambil, 1994), and we suggest this will be similar in medical practices. Further, larger practices may have significant advantages in the marketplace over small practices (Ebben & Johnson, 2005), with Bowen and Wiersema (2005) asserting larger firms have scale economies and market power. It has been suggested that small medical practices face many obstacles relating to e-business activity (Baron, Fabens, Schiffman, & Wolf, 2005), and as such, there is interest in how medical practices can manage e-business (e.g. Lee, Cain, Young, Chockley, & Burstin, 2005; Miller, Sim, & Newman, 2003). Larger practices may also undertake development on a larger scale (Macher & Boerner, 2006), for example, updating all patient records to an electronic database, which smaller practices may not be able to financially afford. The present study explores the interacting effects of practice

size on the relationships between IT inconsistencies and E-Business activity, suggesting that larger practices may have the capacity to over-ride issues and keep activity levels high even when IT inconsistencies increase.

Larger practices may also enjoy additional benefits relating to increased visibility and prestige, and the capacity to endure environmental shocks (e.g., Hannan & Freeman, 1984). Consequently, Mishina, Pollock, and Porac, (2004), suggested that larger firm size is desirable. Further, larger medical practices may have more formal and advanced systems than smaller firms (Busenitz & Barney, 1997), which makes them more equipped to plan and implement technology, allowing for increased efficiency (Ebben & Johnson, 2005). Overall, smaller practices lack the financial resources to engage in large fixed-asset investments (Jarillo, 1989) such as IT systems, and this is important, because IT has been asserted as being important for optimising performance (Ebben & Johnson, 2005). We suggest larger practices will be able to continue to engage in e-business activity even when they face additional IT inconsistencies, due to having superior systems, greater experience, and systems to developed to withstand inconsistencies in the management of e-business within the health system. This leads to our last set of Hypotheses.

Hypothesis 3: Practice size will interact with IT inconsistencies and e-business activity (sending), with larger practices being more able to buffer the negative influence of IT inconsistencies on e-business activity (sending).

Hypothesis 4: Practice size will interact with IT inconsistencies and e-business activity (receiving), with larger practices being more able to buffer the negative influence of IT inconsistencies on e-business activity (receiving).

METHOD

Sample and Procedures

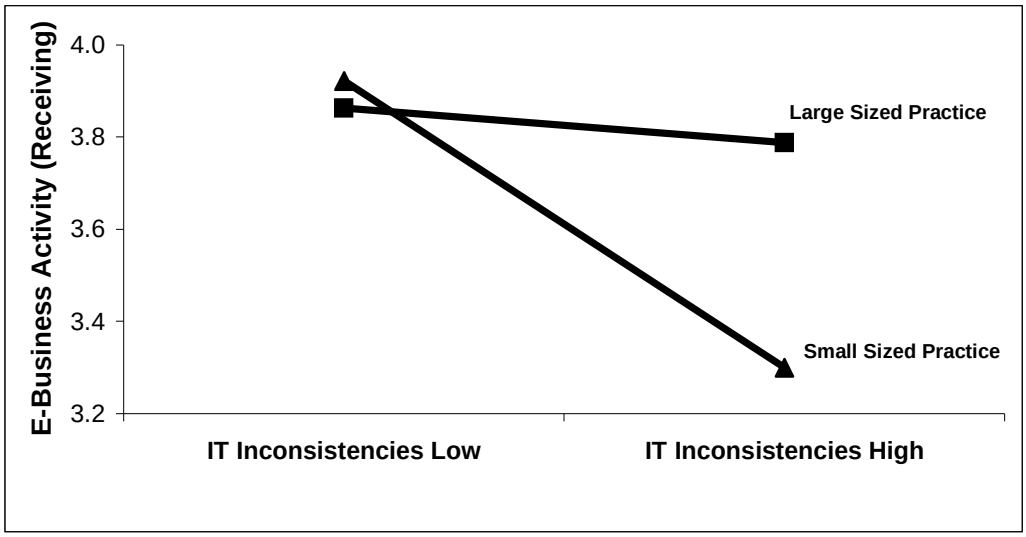
Data were collected from a mail survey to GPs in 250 practices in New Zealand. GPs were surveyed regarding their practice's IT activities (sending and receiving), as well as IT issues and practice characteristics (e.g. number of GPs, number of patients etc.). All letters were specifically addressed to the lead GP in each practice. Of the 250 surveys sent, 108 surveys were returned for a response rate of 43.2%. GPs worked in practices employing on average 4.5 nurses, 4.7 administrators, with 5.1 GPs, 13.7 screens, and 6751 patients.

Measures

E-business activity was measured using 10-items created for this study, based on the e-business activity literature, including sending and receiving. Items were coded (1) = never, (2) = seldom, (3) = sometimes, (4) = usually, (5) = always. A higher score indicates greater e-business activity. An exploratory factor analysis (principal components, varimax rotation) was run to explore the nature of the measure. As expected, the factors split into two with both having eigenvalues greater than one. These were E-Business Activity (Sending) 5-items, Cronbach's alpha of .87 and E-Business Activity (Receiving), 5-items, Cronbach's alpha of .74. IT Inconsistencies was measured using 4-items created for this study, drawn on the literature discussed earlier. Items were coded (1) = never, (2) = seldom, (3) = sometimes, (4) = usually, (5) = always. Respondents were asked to indicate the frequency with problems in using computer-based technology. A higher score indicates greater problems. An exploratory factor analysis (principal components, varimax rotation) was run to explore the nature of the measure. Overall, the items loaded onto a single factor with eigenvalues greater than one, and the measure had an adequate Cronbach's alpha of .81. Practice Size was measured by total number of patients. Practice characteristics were controlled for, specifically: number of screens (number of computer screens), number of nurses (total number of nurses), number of administrators (total number of administrators), and number of GPs (total number of GPs in practice).

RESULTS

IT inconsistencies are not significantly related to E-Business Activity (Sending) (ß= .00, *non significant*). This fails to support Hypothesis 1. However, IT inconsistencies were significantly related to E-Business Activity (Receiving) (ß= -.44, p< .001), supporting Hypothesis 2. From Step 2 we can see that IT inconsistencies do not affect E-Business Activity (Sending) at all (0% variance effect), but do account for 17% (p< .001) of the variance for E-Business Activity (Receiving). While practice size had a significant interaction effect on IT inconsistencies and E-Business Activity (Sending) (ß= .20, p< .05), the failure of the initial direct effect means that Hypothesis 3 is not supported. Practice size did have a significant interaction effect on IT inconsistencies and E-Business Activity (Receiving) (ß= .16, p< .05), accounting for an additional 2% (p< .1) of the variance towards E-Business Activity (Receiving). To facilitate interpretation of the significant moderator effects of practice size on E-Business Activity (Receiving), plots of the interactions are presented in Figure 1. On this Figure, IT inconsistencies low and high represents points below and above the mean (M=2.4), and this is the same for the graphed lines for practice size (M=6751), labeled small sized practice (below the mean) and large size practice (above the mean).



Plotting the interaction terms (Figure 2) illustrates that when IT inconsistencies are low, there is a no difference between responding practices, regarding their levels of E-Business Activity (Receiving). However, when IT inconsistencies increase to high, larger sized practices report only a slight decrease in E-Business Activity (Receiving), while smaller sized practices report significant reductions in E-Business Activity (Receiving). Overall, this effect supports Hypothesis 4.

Overall, the regression model for predicting E-Business Activity (Sending) was not significant (R^2 = .10, F = 1.376, *non significant*), while the model for predicting E-Business Activity (Receiving) was significant (R^2 = .31, F = 5.746, p< .001). Finally, we examined the variance inflation factors (VIF) for evidence of multicollinearity, which occurs at values of 10.0 or higher (Neter, Kutner, Nachtsheim, & Wasserman, 1996; Ryan, 1997). All the scores were well below the suggested scores, with the interaction effects being less than 1.1. Overall, the findings indicate no evidence of multicollinearity unduly influencing the regression estimates.

DISCUSSION

Dowd et al. (2005) asserted that IT was critically important for enhancing patient care and ultimately performance in the complex health sector. However, the uptake of IT in health has been particularly slow when compared with other industry sectors, due to the multiple issues, problems, and inconsistencies associated with the wide variety of needs of its stakeholders. The present study explored the influence that IT inconsistencies might have on medical practice e-business activities. These findings supported our hypothesis that greater IT inconsistencies negatively influence e-business activity, although only towards receiving electronic data and not sending it. Consequently, we found medical practices experiencing greater issues and problems associated with IT, including inconsistencies in uptake and standardization, programme incompatibility and lack of speed by government health providers, were unable to maximize the efficiency of e-business regarding receiving data. However, these inconsistencies did not influence sending activity, indicating that the issues mentioned above do not hamper medical practices that wish to send electronic health data.

The other major aspect of the present study was the exploration of medical practice size as a potential moderator of the relationship between IT inconsistencies and e-business activity. We hypothesized that larger sized practices would have additional resources to leverage which would enable them to endure environmental shocks (Hannan & Freeman, 1984), such as inconsistencies in the IT environment within the health sector. As expected, we found larger sized practices were able to buffer the negative influence of IT inconsistencies, with larger firms being able to maintain a relatively similar level of e-business activity (receiving) irrespective of whether IT inconsistencies were low or high. Further, smaller sized practices held similar levels of e-business activity (receiving) as larger practices until IT inconsistencies became high. Then, they reported a significant drop in e-business activity (receiving), reducing their level of activity to well below that of larger practices. As such, it appears that larger practices are able to maintain stronger levels of e-business activity even when there are pressing issues relating to uptake, standardization, incompatibility and speed. Perhaps their greater financial resources, more developed policies, and greater team opportunity, allow them to navigate the inconsistencies of IT far better than their smaller sized counterparts. We encourage further moderation studies of medical practices to see whether practice size has a consistent effect on buffer the worst issues associated with IT in the health sector.

While numerous problems have been identified as influencing the adoption on IT in the health sector (Grimson et al. 2000; Dowd et al. 2005), it appears that many IT related issues may not always adversely affect medical practices. The lack of affect on e-business activity (sending) means that practices wishing to conduct their business through the Internet are not affected by the inconsistencies in the system. However, the extent to which medical practice activities are efficient and constructive is an area where further research is required. For example, if e-business is conducted outwards from the practice irrespective of problems and issues, but e-business traffic entering the practice is affected by IT inconsistencies, how do medical practices know they are operating efficiently? Indeed, they might assume other practices, specialists, and hospitals are receiving their information adequately, however, the evidence found here is that this might not be the case.

Overall, we find that the IT environment in the New Zealand health sector does appear to detrimentally affect the ability of medical practices to operate their IT effectively, although larger practices are able to buffer and overcome this environment. The implication for medical practices looking to add or expand the role of IT is that larger sized practices will allow for greater e-business activity regarding receiving data even in a poor IT environment, which might ultimately encourage consolidation amongst smaller medical practices.

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